Space Weather Technical Forecast

Issued on Sunday, 02 October 2022 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2 Minor to Moderate storming possible into Day 3 (04 Oct). M-class flares Likely throughout. Chance of S1/Minor radiation storm during Day 1 (02 Oct). Chance of Active electron fluence later in the period.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate over the last 24 hours, with an M5.8 flare observed at 01/2010 UTC, from AR3110 in the northwest. This region has developed a north-south aligned magnetic structure, which may contribute to some magnetic instability. AR3112, which continues to rotate into view on the northeast limb, is the largest region. It is currently difficult to classify due to foreshortening near the limb, but it has been the source of several CMEs over recent days. There are currently six numbered sunspots on the Earth-facing disc. The remaining regions appear largely stable with little change.
CMEs have been observed from AR3113, which may glance Earth, and more recently from AR3110 in association with the M5.8 flare. Both are still undergoing analysis but some Earth directed component is possible from each of them.

Solar Wind / Geomagnetic Activity: Solar wind parameters at L1, as measured by the ACE satellite, are indicative of an ongoing weak HSS, with a weak CME arrival at 01/1505 UTC. Wind speeds were slightly elevated, mostly in the range 400-500km/s. Density was below average, but jumped to above average with the CME arrival. The total IMF, Bt, was weak, jumping to moderate when the CME arrived. The north-south component, Bz, varied weakly. The phi angle was positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, is currently just above normal background levels, below the S1/Minor Storm threshold. High energy electron flux (greater than 2 MeV) was at background levels. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 02/0000UTC was 1.46e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to be Low to Moderate, with further M-flares likely from AR3112, AR3110 and AR3113.

Solar Wind / Geomagnetic Activity: Two CMEs have erupted from the northwest quadrant in recent hours. Both are still being analysed, and may glance Earth. Arrival times are uncertain at present, but late Day 2 or early Day 3 (03-04 Oct) currently seems most likely. Solar winds are slightly elevated and on a steady trend. A further increase is likely due to the recurrent CH28/+. There is some uncertainty though due to Enlil suggesting a slower arrival of the HSS influence. Solar winds are still considered likely to rise during Day 1 (02 Oct), with a peak of 600-700km/s. Geomagnetic activity will be Quiet initially, before increasing to Active to G1/Minor storm (Kp 4-5) as CH28 arrives, with a chance of G2/Moderate storm levels (Kp 6). There is also just a slight chance of an isolated G3/Strong storm (Kp 7) interval. Enhanced conditions may be continued into Day 3 if either of the recent CMEs arrive. Geomagnetic activity perhaps starting to ease

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during Day 4 (05 Oct).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is currently above background after the recent M5.8 flare from the northwest. There is a chance proton levels will breach the S1/Minor Storm threshold during Day 1 (02 Oct), with a gradual decrease likely thereafter in the absence of further large flares from the western hemisphere. The high energy (greater than 2MeV) electron flux has been at background levels. A rise in electron flux may occur after the HSS from CH28, but this will be complicated by the potential for 2 CME arrivals on Days 2 or 3 (03-04 Oct) which would suppress electron levels. If the CME arrival(s) do not occur, a rise is possible during this period but confidence is low. The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but perhaps with a rising trend.

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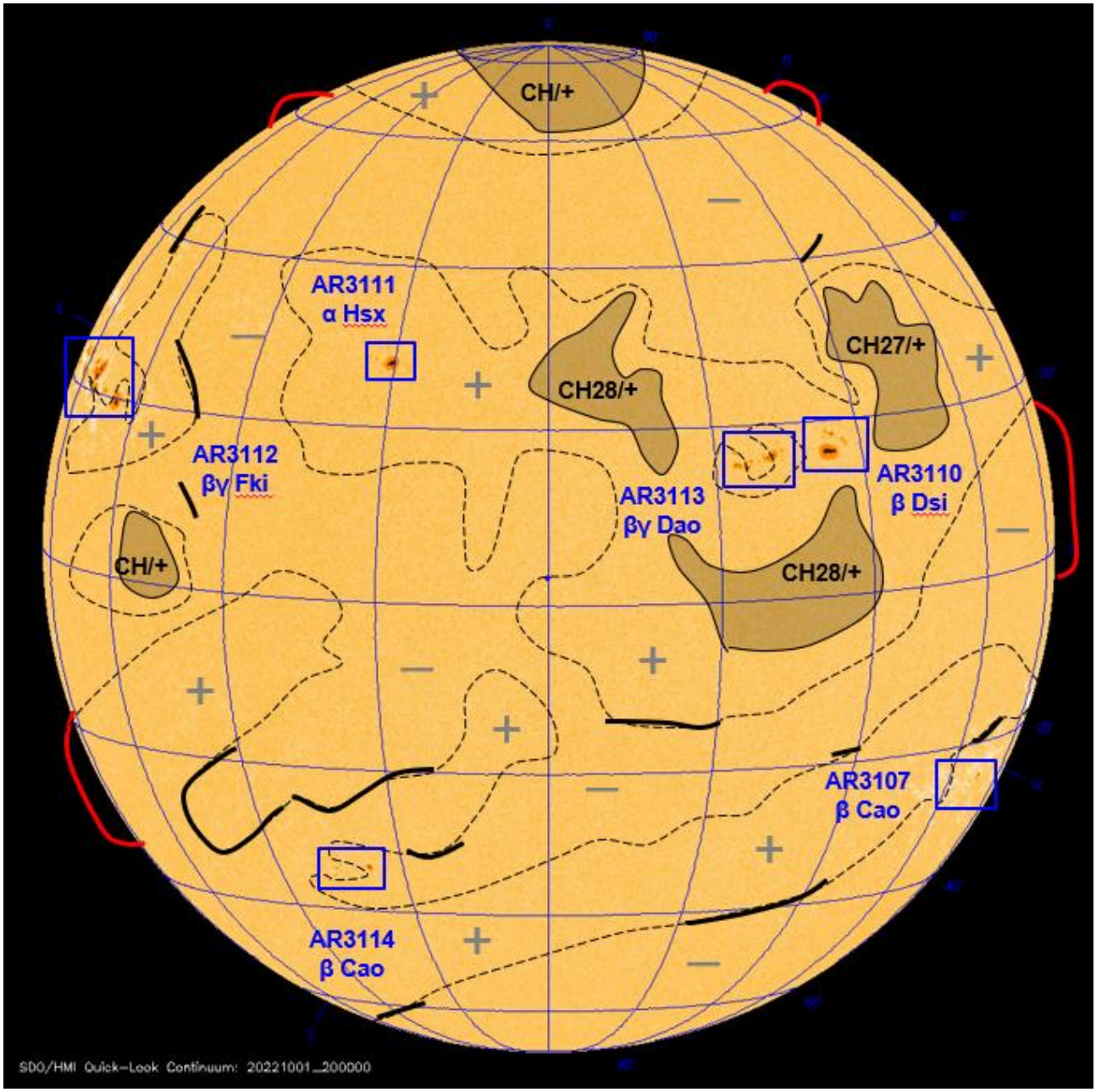
Figure 1. Solar Analysis Valid 01/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two CMEs have erupted from the northwest quadrant in recent hours - one from AR3113 starting around 01/1200 UTC and another from AR3110 associated with the M5.8 flare at 01/2010 UTC. Both are still being analysed, and both may glance Earth. Arrival times are uncertain at present, but late Day 2 or early Day 3 (03-04 Oct) currently seems most likely.

Solar winds are currently slightly elevated and on a steady trend. A further increase is likely due to the recurrent CH28/+ which brought an extended period of Minor to Moderate geomagnetic storming on the last rotation. Similar activity is considered likely on this occasion, especially as the autumn equinox has recently occurred. There is some uncertainty though due to Enlil suggesting a slower arrival of the HSS influence, and indeed the increased wind speeds are already later than originally expected. Solar winds are still considered likely to rise during Day 1 (02 Oct), with a peak of 600-700km/s.

Geomagnetic activity will be Quiet initially, before increasing to Active to G1/Minor storm (Kp 4-5) as CH28 arrives, with a chance of G2/Moderate storm levels (Kp 6). There is also just a slight chance of an isolated G3/Strong storm (Kp 7) interval. Enhanced conditions may be continued into Day 3 if either of the recent CMEs arrive, perhaps later on Day 2 or early on Day 3. Geomagnetic activity perhaps starting to ease during Day 4 (05 Oct).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	40	10
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1643	Partial	AR3113	NW	850	04/0300 UTC	Low confidence glancing blow

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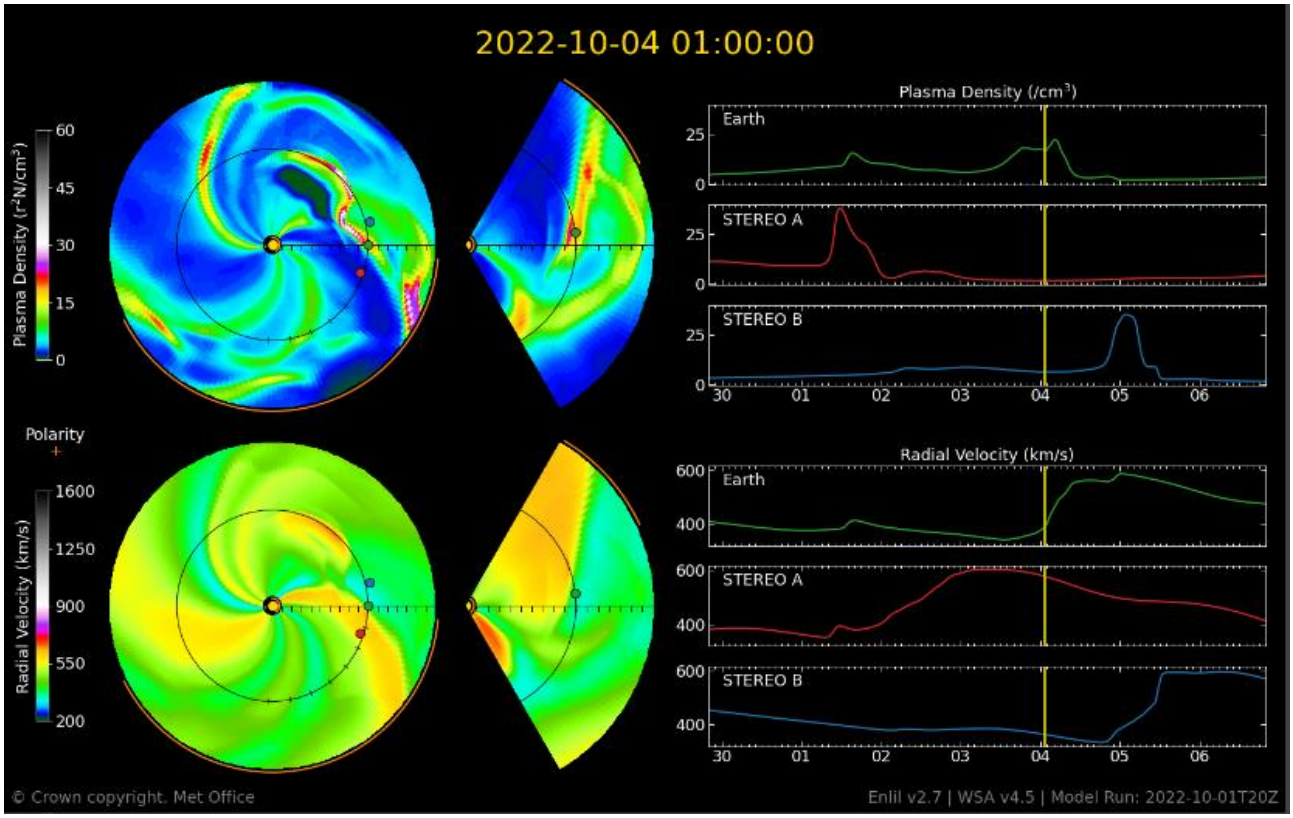
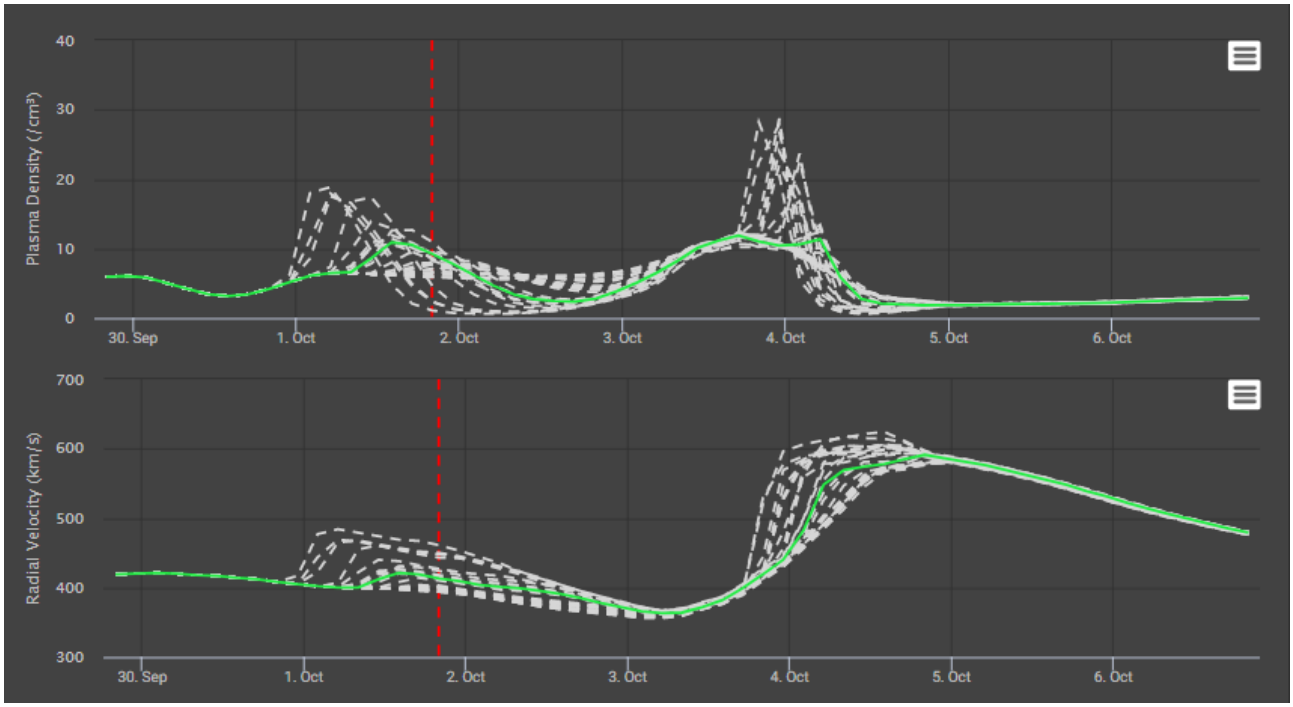
Figure 2: MOSWOC Enlil and ensemble showing a possible CME arrival early on 04 Oct. A second more recent CME has not yet been modelled.





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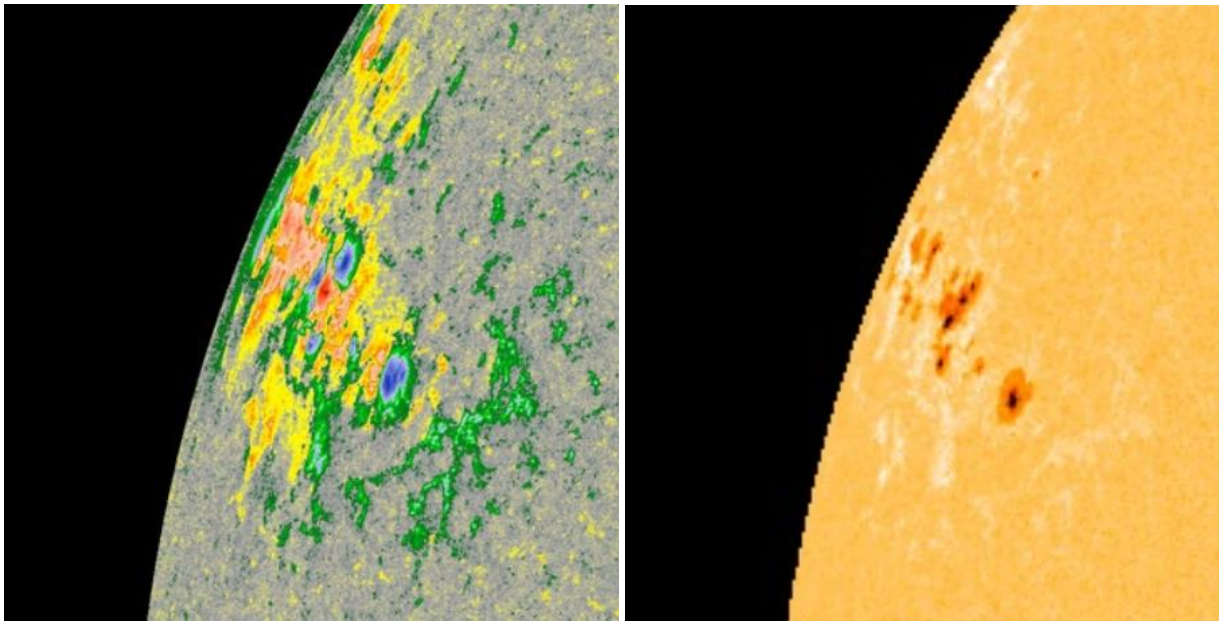
Radio Blackouts - X-Ray Flares:
There are currently six numbered sunspots on the Earth-facing disc. Solar activity has been Moderate in the last 24 hours, with an M5.8 flare at 01/2010 UTC from AR3110 (Dsi/Beta) in the northwest. This region has developed a north-south aligned magnetic structure, which may contribute to some magnetic instability. AR3112 (tentatively Fki/Beta-Gamma), which continues to rotate into view on the northeast limb, is the largest region. It is currently difficult to classify due to foreshortening near the limb, but it has been the source of several CMEs over recent days. It may be that there are two separate regions but foreshortening makes it difficult to tell at present. AR3113 (Dao/Beta-Gamma) has shown little change, although development of negative polarity spots leading the group gives it a beta-gamma classification. The other regions appear largely stable with little change.

Further isolated M-class flares are considered likely, mainly due to AR3112 in the northeast, but also from AR3110 and AR3113 in the northwest.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: AR3112 in the northeast is still difficult to classify due to the viewing angle.



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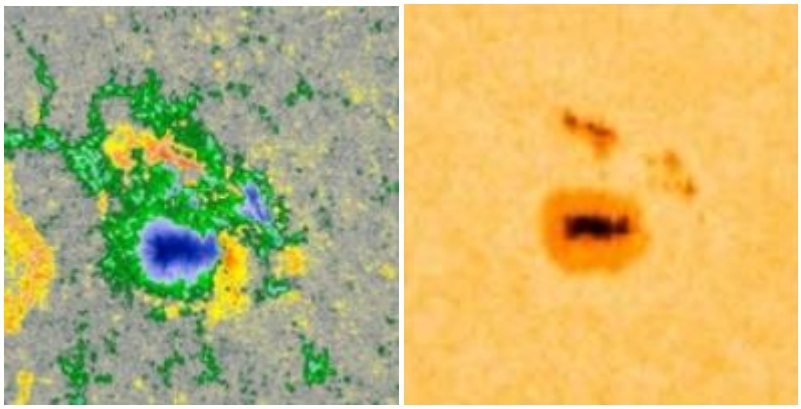
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) as observed by GOES16, is currently above background after the recent M5.8 flare from AR3110 in the northwest. A further rise is possible, with a chance that proton levels will reach the S1/Minor Storm threshold during Day 1 (02 Oct). After Day 1, a gradual decrease in levels is most likely, in the absence of further large flares from the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	20	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: AR3110 was responsible for the recent M5.8 flare and slight proton enhancement. A north-south magnetic field alignment may be contributing to magnetic instability.



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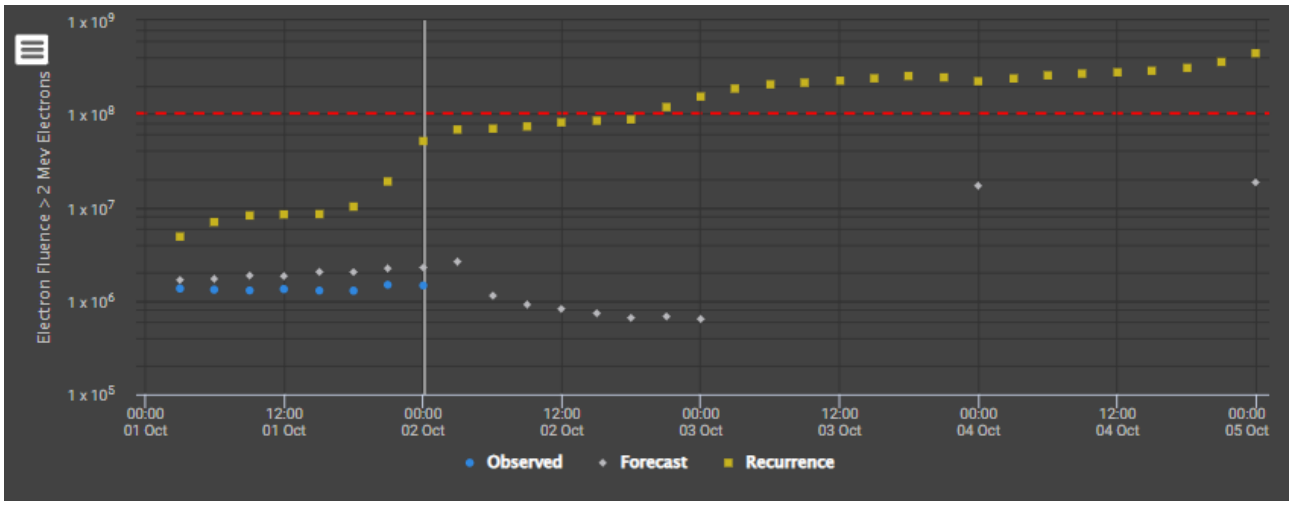
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2MeV) electron flux, as observed by GOES-16 has been at background levels. A rise in electron flux may occur once the fast winds from CH28 start to ease, although the peak winds from this feature are either late or not going to be as strong as originally forecast. However, this will be complicated by the potential for 2 CME arrivals on Days 2 or 3 (03-04 Oct) which would suppress electron levels. If the CME arrival(s) do not occur, a rise is possible during this period but confidence is low.

The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but perhaps with a rising trend. MOSWOC REFM is currently forecasting a slight rise below Active levels, but will not be taking account of any CME arrival.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM is currently showing a slight rise below the Active (1e8 integrated pfu) threshold. This won't take account of any potential CME arrivals.



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